

Memo

To: Rory Swiderski

From: Jarrad Clark

Date: 10 May 2019



Subject: Subterranean fauna likelihood of occurrence assessment conducted for the proposed Worsley Mine Expansion – Worsley Mine Development Envelope and Bauxite Transport Corridor

Version History

Report	Version	Prepared / Approved By	Date Submitted to Client
Draft Report	V1	Jarrad Clark	20/12/2019
Draft Report	V2	Jarrad Clark	10/02/2019
Final Report	V3	Jarrad Clark	10/05/2019

Dear Rory,

This memo documents an assessment of the likelihood of occurrence of subterranean fauna conducted for the proposed Worsley Mine Mining Development Envelope (WMDE) and proposed Bauxite Transport Corridor component of the proposed Worsley Mine Expansion (WME) Project.

1 CONTEXT

South32 Worsley Alumina Pty Ltd (South32) is proposing to expand existing mining activities at the Worsley Alumina Operation (Boddington Bauxite Mine (BBM) and the Worsley Refinery) as part of the WME.

The Primary Assessment Area (PAA) of the WME includes the Worsley Mining Development Envelope (WMDE), Bauxite Transport Corridor (BTC), Contingency Bauxite Mining Envelope (CBME) and maintenance within the Refinery Lease Area (RLA). The estimated totals for these areas are:

- WMDE covers a land area of 27,796 ha, which includes the Pre-existing Approval Area and an overlapping land area of 3,332 ha with the Bauxite Transport Corridor
- The Bauxite Transport Corridor covers a land area of 4,146 ha
- CBME covers a land area of 747 ha
- Maintenance within the Refinery Lease Area covers a land area of 5 ha

The PAA (incorporating the WMDE, BTC, CBME and Maintenance within the RLA) represents a total of 29,362 ha (excluding the overlap area of 3,332 ha) and 32,694 ha (including the overlap area).

This preliminary assessment for Subterranean Fauna overlaps the proposed PAA for the WMDE and Bauxite Transport Corridor. This assessment does not include the CBME or Maintenance within the RLA, as these areas are addressed in the Subterranean Fauna Likelihood of Occurrence Assessment for the CBME (10 May 2019; Phoenix 2019).

Current mining activities will continue to operate throughout the duration of the assessment process for this Proposal, including transport of ore via the overland bauxite conveyor through to the Refinery.

Mining activities involve the salvaging of forest products, clearing of vegetation, stripping of topsoil and removal of overburden, preparation of blasting areas with surface miners, caprock blasting, excavation, the establishment of mine haulage roads, transport of ore to a crushing facility, ore stockpiling, ore crushing and transport of crushed ore to a conveyor, and related activities. All mining activities will occur within the WMDE.

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Bauxite mining at BBM occurs in the upper 8-12 m bauxite layer and to a maximum depth of approximately 40 m dependent on depth to caprock.

2 SCOPE OF WORK

The scope of work was as follows:

- conduct a brief subterranean fauna risk assessment, that included:
 - a search of the WA Museum Arachnida/Myriapoda and Crustacea databases
 - review of records from surveys in the vicinity of the proposed WMDE and Bauxite Transport Corridor
- review of geological and hydrogeological information for the proposed WMDE and Bauxite Transport Corridor
- based on the above, determine the likelihood of occurrence of a diverse, abundant and conservation significant subterranean fauna assemblage.

3 OVERVIEW OF SUBTERRANEAN FAUNA

For the purposes of environmental impact assessment (EIA), the EPA (2016a) defines subterranean fauna as: *fauna which live their entire lives (obligate) below the surface of the earth*. They include stygofauna (aquatic and living in ground water) and troglofauna (air-breathing and living in caves and voids). The EPA's objective with respect to subterranean fauna is *its protection so that biological diversity and ecological integrity are maintained*.

The obligate underground existence with of subterranean fauna greatly increases the likelihood of short-range endemism and the possibility that a species' conservation status may be impacted as a result of the implementation of a proposal. Subterranean fauna species may therefore be considered to be significant due to (EPA 2016a):

- being identified as Threatened or Priority species
- locally endemic
- potentially new species
- occupying restricted habitats
- forming part of a Threatened or Priority Ecological Community.

The likelihood of occurrence of subterranean fauna in most geologies within the southwest is considered low (EPA 2016b), except for in karst limestone, where it is considered high.

4 METHODS

The study area for the risk assessment was defined as the proposed WMDE and Bauxite Transport Corridor with a buffer of approximately 65 km, and included:

- a review of troglofauna and stygofauna records held by the WA Museum Arachnology, Myriapodology and Crustacea databases (NW corner: 32.6207S/116.2976E; SE corner: 33.0809S/ 116.6023E), within 5 km of the study area
- a review of any applicable published or unpublished subterranean fauna surveys, within approximately 100km of the study area

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- a review of geological and hydrogeological spatial datasets for the proposed WMDE and Bauxite Transport Corridor.

5 RESULTS

5.1 FAUNA

No troglofauna or stygofauna have been recorded within 5 km of the proposed WMDE and Bauxite Transport Corridor (WAM 2018).

A relatively recent stygofauna survey to the west of the study area at Murray (~56 km WNW), found stygofauna to be present in 10% of the 20 bores sampled; Three previously unknown species were recorded (GHD 2010). This survey however was undertaken within sand and limestone (to the west) and sand and clay (to the east) lithologies, of superficial, unconfined aquifers of the Perth basin and is therefore of limited applicability to the current study area, which occurs east of the Darling Fault, within the Northern Jarrah Forest (JAF01) (Cowan 2001).

The most comparable recent project to be assessed by the EPA was the expansion of the Boddington Gold Mine, which is located immediately north of the BBM in the Jarrah Forest Bioregion (JAF01; DoE 2012). Here a subterranean desktop assessment was undertaken (Outback Ecology 2012). The assessment concluded that in the context of the proposed expansion of the waste rock dump and residue disposal, significant stygofauna or troglofauna communities were unlikely to occur; no surveys were undertaken. Subsequently the Life of Mine Project was approved and subterranean fauna was not considered a significant environmental factor in the EPA's assessment of the Project (Strategen 2013).

A second comparable Project is the Talison Lithium Australia Pty Ltd (Talison) Greenbushes Lithium Mine, which is located within the Jarrah Forest Bioregion approximately 116 km SSE of the study area (JAF02; DoE 2012). It has operated for over 30 years. No subterranean fauna surveys have been conducted historically or in the context of the expansion proposal. In June 2018, Talison applied to expand the mine by 25%. The EPA referral notice indicates that subterranean fauna will not be considered a significant environmental factor in the assessment (EPA 2018).

5.2 GEOLOGY/REGOLITH

The proposed WMDE and Bauxite Transport Corridor is located on the Yilgarn Craton, a stable shield area, consisting of linear belts of metamorphosed sedimentary and volcanic rocks that have been intruded with granitic rocks (granitoid formation) (Golder Associates 2004).

The surface geology as defined by Stewart et al (2008) comprises eight units (Table 1), the largest of which is ferruginous duricrust (laterite). The laterite includes the bauxite which is to be mined.

The laterite consists of a ferruginous or aluminous hard cap layer, often cemented and generally only two meters thick. This duricrust overlies a pallid, impermeable kaolinitic clay zone of varied thickness.

The other dominant geologies (amphibolite; felsic intrusives; gneiss, granulite, migmatite; felsic volcanic rocks and porphyry) are also relatively impermeable.

Table 1 Surface geological units of the study area (Stewart et al. 2008)

Unit name	BTC		WMDE		WME	
	ha	%	ha	%	ha	%
Ferruginous duricrust	1,858.3	45%	16,111.7	58%	16,330.4	57%
Amphibolite	341.5	8%	4,391.9	16%	4,391.9	15%
Felsic intrusives	860.4	21%	2,768.5	10%	3,220.2	11%

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Gneiss, granulite, migmatite	-		1,867.3	7%	1,867.3	7%
Felsic volcanic rocks and porphyry	678.2	16%	1,361.4	5%	1,382.2	5%
Alluvium	371.3	9%	911.9	3%	1,026.6	4%
Sand plain	-		205.9	1%	205.9	1%
Colluvium	36.1	1%	177.6	1%	185.3	1%
Total	4,145.8	100%	27,796.2	100%	28,609.7	100%

Together the dominant five geological units by area (all metamorphic and igneous formations) comprise 90% of the BTC, 95.3% of the WMDE and 95% of the WME, and are considered unlikely to support a diverse and/or abundant troglofauna fauna assemblage.

5.3 HYDROGEOLOGY

The hydrogeology of the study area is described by Commander (1989) and DWER (2002) as containing rocks of low permeability (fractured and weathered rocks), being undifferentiated volcanic and sedimentary rocks in greenstone belts and granitoids; with minor groundwater resources are present.

Golder Associates (2004) undertook a hydrogeological assessment of the proposed new mining areas, drawing on information from interpretation of geological mapping and groundwater investigations of paired catchment studies within the area as little hydrogeological mapping exists. They describe four units that are considered to be the main aquifers of the region (Golder Associates 2004):

- 1) **Lateritic regolith** – covers the majority of the landscape throughout the entire area. It is typically a 20–30 m thick section of weathered lateritic regolith, that comprises a surficial deposit of humus rich sandy loam with a high gravel content over cemented duricrust (rock-like materials of quartz and weathered rock), over mottled and pallid zone clays
- 2) **Weathering zone** – grades from the pallid clay zone materials to basement rock. Recharge typically occurs via direct infiltration from rainfall.
- 3) **Bedrock aquifers** – poor groundwater producer, but water can occur in fractures and faults. It is recharged from rainfall predominately via the overlying profiles.
- 4) **Dykes** – not an aquifer source, but act to impede or facilitate groundwater movement within the profile; groundwater can occur in significant joints and fractures. May disrupt groundwater flow and cause raised water tables.

The four zones that comprise the majority of the study area are considered unlikely to support a diverse and/or abundant stygofauna assemblage due to the cemented nature of the lateritic regolith and the high clay content of the underlying weathering zone.

6 CONCLUSIONS

The proposed WMDE and Bauxite Transport Corridor occurs within the southwest of WA, an area generally known to have low prospects for subterranean fauna presence for non-karst geologies (EPA 2016b). A review of the local geology and hydrogeology has found that the area is dominated by low permeability lithologies (dominated by lateritic duricrust 45%–58%; often cemented), over pallid, kaolinitic (clay) zones of varied thicknesses, over bedrock; with only minor local aquifers present. Karst is not present.

The WA Museum database searches revealed no subterranean fauna species known within 5 km of the WMDE and Bauxite Transport Corridor. A review of published and unpublished literature has failed to find any additional data in close proximity to, or applicable to the Project, which may provide evidence to the contrary.

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It is therefore concluded that subterranean fauna is unlikely to be present and thus development of the proposed WMDE and Bauxite Transport Corridor presents a low risk to subterranean fauna. Further two relatively recent Project expansions within the Jarrah Forest Bioregion (JAF01 and JAF02; EPA 2018; Strategen 2013) have not conducted field surveys for subterranean fauna as the EPA did not consider subterranean fauna to be significant environmental factors.

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Yours Sincerely,

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7 REFERENCES

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